SINTEF REPORT

SINTEF Applied Chemistry

Address: N-7465 Trondheim, NORWAY
Location: S.P. Andersens vei 15A
Telephone: +47 73 59 20 80 / 12 12
Fax: +47 73 59 70 51

Enterprise No.: NO 948 007 029 MVA

TITLE

Users Manual
Minerals Management Service Pipeline Oil Spill Volume Computer Model Final

AUTHOR(S)

Mark Reed, May Kristin Ditlevsen, Ben Hetland, Morten Haug Emilsen, Øistein Johansen, Boye Hoverstad

CLIENT(S)

U.S. Minerals Management Service
Herndon, Virginia USA

REPORT NO.	CLASSIFICATION	CLIENTS REF.	
STF66 F02100	Confidential	Sharon Buffington, U.S. Minerals Management Service	
CLASS. THIS PAGE	**ISBN**	**PROJECT NO.**	**NO. OF PAGES/APPENDICES**
Confidential		661247	26
ELECTRONIC FILE CODE		**PROJECT MANAGER (NAME, SIGN.)**	**CHECKED BY (NAME, SIGN.)**
Users Manual-WCD Final.doc		Mark Reed	Henrik Rye
FILE CODE	**DATE**	**APPROVED BY (NAME, POSITION, SIGN.)**	
	2002-09-24	Tore Aunaas, Research Director	

ABSTRACT

The Pipeline Oil Spill Volume Computer Model (POSVCM) provides a methodology to estimate discharges from seafloor pipelines. The system is composed of a Release Module and a Near Field Module, linked together with necessary databases through a Graphical User Interface (GUI). This document describes the use of POSVCM. Inputs to the model are parameters describing the configuration and characteristics of a pipeline system, the fluid it contains, and the leak or break from which the discharge occurs. Key outputs are the evolution of the release rate over time, the total mass of oil released, and a measure or the mean thickness of any eventual surface slick being formed.

KEYWORDS	ENGLISH	NORWEGIAN
GROUP 1	Offshore, Environment, Oil Spills	
GROUP 2	Marine environmental model	
SELECTED BY AUTHOR	Seafloor pipelines, leaks	

Table of Contents **Page**

1 Introduction

The Pipeline Oil Spill Volume Computer Model (POSVCM) provides a methodology to determine worst-case discharges from seafloor pipelines. Inputs to POSVCM are parameters describing the configuration and characteristics of a pipeline system, the fluid it contains, and the leak or break from which the discharge occurs. Key outputs are the evolution of the release rate over time, the total mass of oil released, and a measure or the mean thickness of any eventual surface slick being formed. The system is composed of a Release Module and a Near Field Module, linked together with necessary databases through a Graphical User Interface (GUI).

Limitations of application are:

- Single “tree” network” with all branches (pipelines) converging toward a single outlet point at its root;
- No closed re-circulating loops;
- One and only one leakage point;
- Maximum of 100 pipeline segments per branch (i.e. between junctions) and 5 junction points;
- Maximum of 5 pipeline segments attached to a single junction;
- Only pipeline objects may connect directly to nodes (i.e. junctions or connectors);
- Pipeline object connected to non-pipeline objects at both ends;
- Maximum of 50 branches (series of Pipeline objects between junctions);
- Connection object connects exactly two pipeline objects;
- Junction object connects at least 3, and not more than 10 pipeline objects;
- An Inlet must be at the start of an incoming branch;
- Outlet object must connect to only one incoming pipeline object;
- Leakage point must be attached to a Pipeline object
- Diameter of leak cannot exceed pipe diameter. (This is checked and corrected automatically in the Release Module.)

Necessary inputs for simulation of a given scenario are:

- Fluid properties:
  - Oil density
  - Gas density (can default to 1 kg/Sm^3)
  - Gas-Oil Ratio
  - Percent water in fluid
- Flow inlet properties:
  - Depth (positive down; negative above mean sea level)
  - Total liquid flow rate (oil plus water plus gas)
  - Fluid temperature
  - Closing (or shut-in) time
- Pipeline or riser segment
  - Length
  - Inside diameter
  - Roughness coefficient (can default to 5.0 x 10^{-5})
  - Heat transfer coefficient (can default to 1 J/s)
  - Ambient temperature
- Pipe connector or junction
  - Depth
- Outlet (to remainder of pipeline system or storage
  - Depth

    - Fluid pressure
    - Closing (or shut-in) time
- Leak properties
    - Distance from upstream endpoint
    - Nominal diameter (not larger than pipeline diameter)
    - Water depth.

1.1 Installation

Insert the CD and run setup.exe to install the program. Double-click the POSVCM.exe file and the main window appears with an empty work desk, Figure 1.1.

Click objects on the toolbar and click again on the work-desk to construct a diagram of the pipeline system of interest. When the diagram is printed or saved, the contents of the work-desk will be saved.

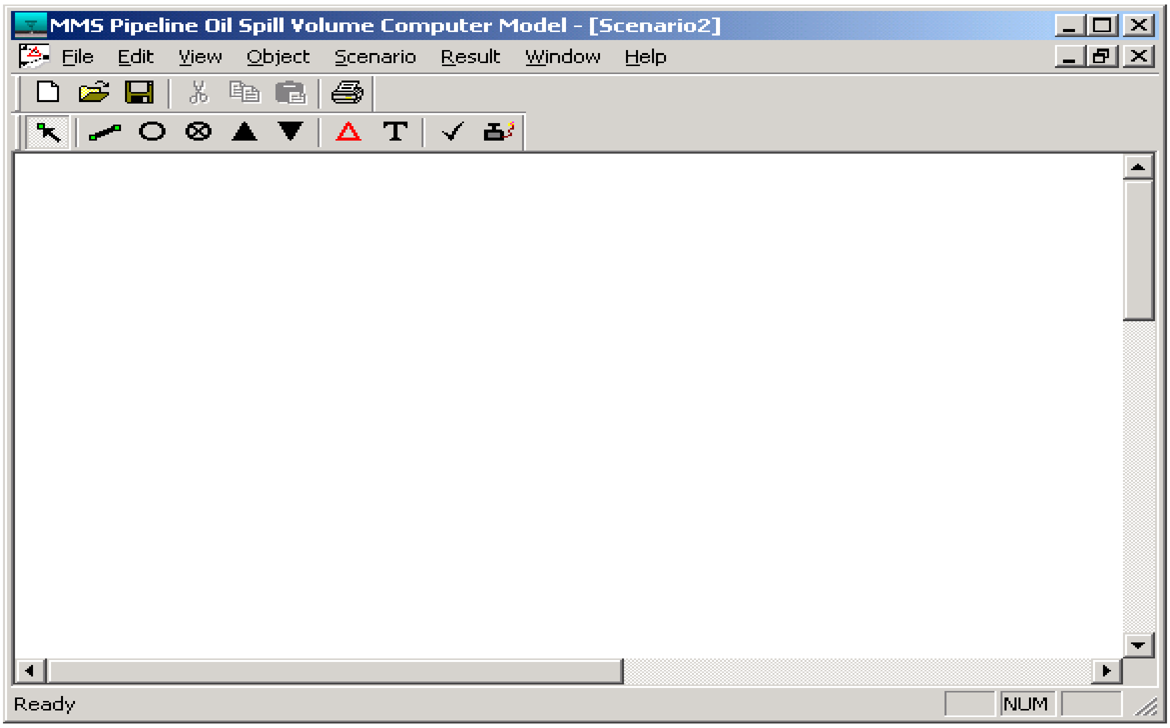


Figure 1.1 Main window for The Pipeline Oil Spill Volume Computer Model (MMS-POSVCM).

1.2 Create a new scenario

A scenario consists of a constellation of connected objects, each of which is assigned a set of parameters. Under the Object menu or on the object toolbar one has six options:

- Pipeline
- Connection
- Junction
- Inlet
- Outlet
- Leakage

The parameters defining each object are given in Table 1.1.

Object	**Parameters**				
Pipeline Segment	Length	Diameter	Roughness	Heat Transfer Coefficient	Ambient Temperature
Connector	Depth				
Junction	Depth				
Inlet (Flow Source)	Depth	Flow Rate	Fluid Temperature	Closing (or Shut-in) Time	
Outlet (Flow Sink)	Depth	Pressure			
Leak Point	Distance from upstream endpoint	Nominal Diameter	Depth at leak location	Back Pressure	

Table 1.1 Parameters defining objects in a discharge scenario.

Choose the component you want to place on your work desk, and click it into the work area.

When a pipeline segment or leak point is inserted into the work area, it will appear with small green boxes defining the connection points. Pipeline segments can be resized by dragging one of these green boxes. Objects can be moved on the work-desk by click-and-drag.

To delete an object, click on the object and press the Delete key (or use the Delete command under the Edit menu).

All objects must be connected together before a scenario will run. Pipelines and Leak Points can connect to Connectors, Junctions, Inlets, and Outlets at any of their blue connection markers. The green box in the center of the Leak Point, or at the end of the Pipeline segment, will turn red when the connection has been properly made.

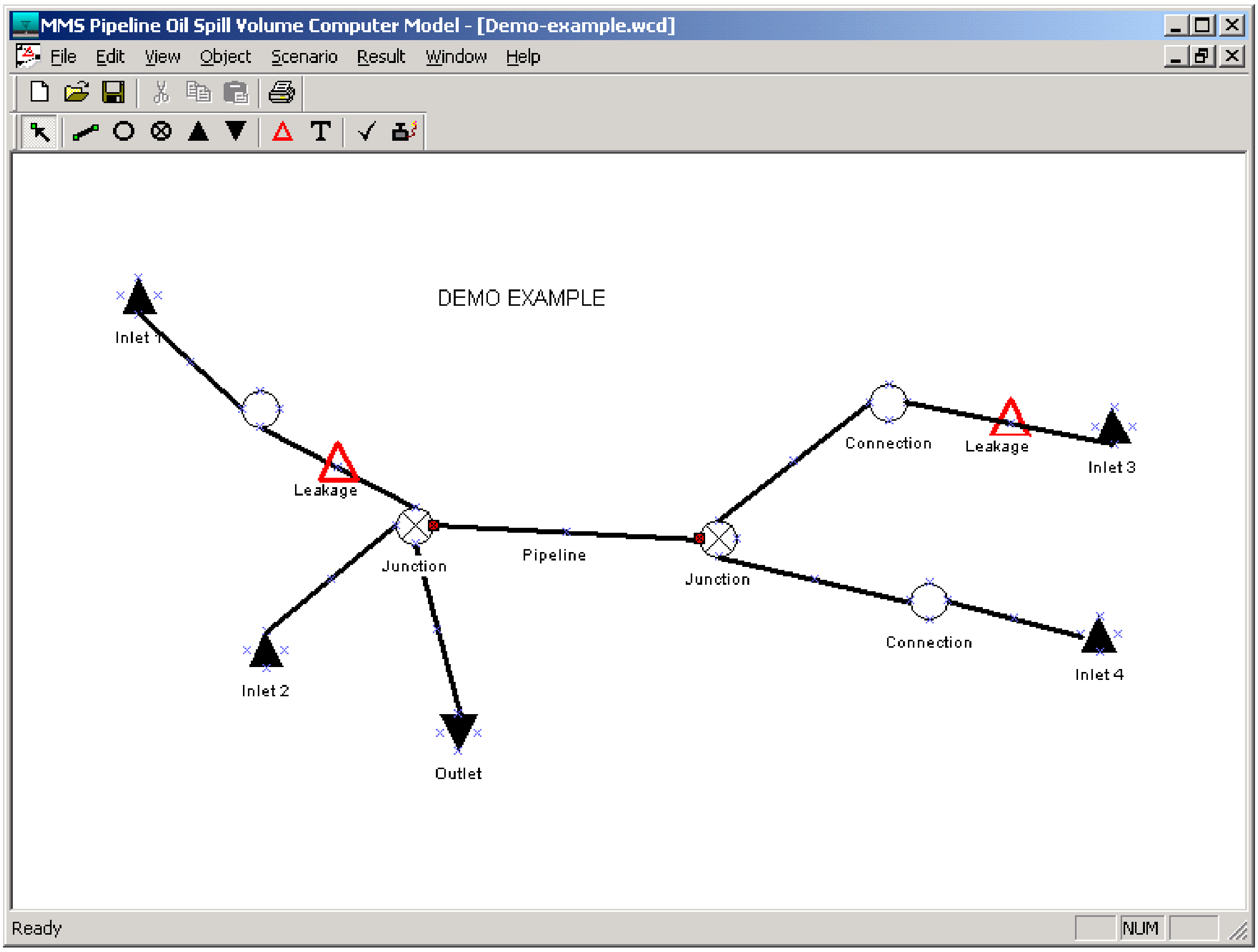
To verify that a connection has been properly made, click and drag the Connector, Junction, Inlet, or Outlet (not the Pipeline Segment or Leak Point), and see that the attached object follows after. (Clicking on the pipeline element will detach it from its connectors and junctions.)

Notes:

1. When opening an existing scenario, some pipelines may appear to be disconnected from their junctions and connectors. This is a only visual effect resulting from the use of long text strings in names of elements, and does not affect the integrity of the scenario. These

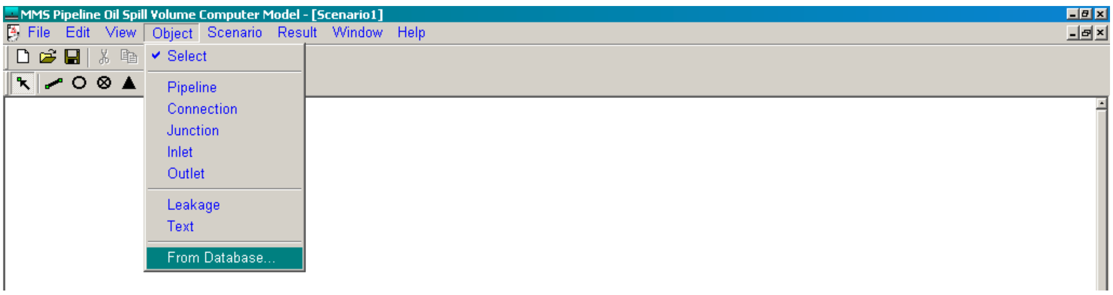
text strings mask the placement of objects. Simply click on the junctions and connectors, and the pipelines will return to their correct positions.

2. The layout on the desktop is generally not to scale. Only the parameters such as length and depth) allocated to each element in the diagram are used in the actual calculations. Moving an object manually on the desktop will not alter the basis for the computations in the POSVCM.

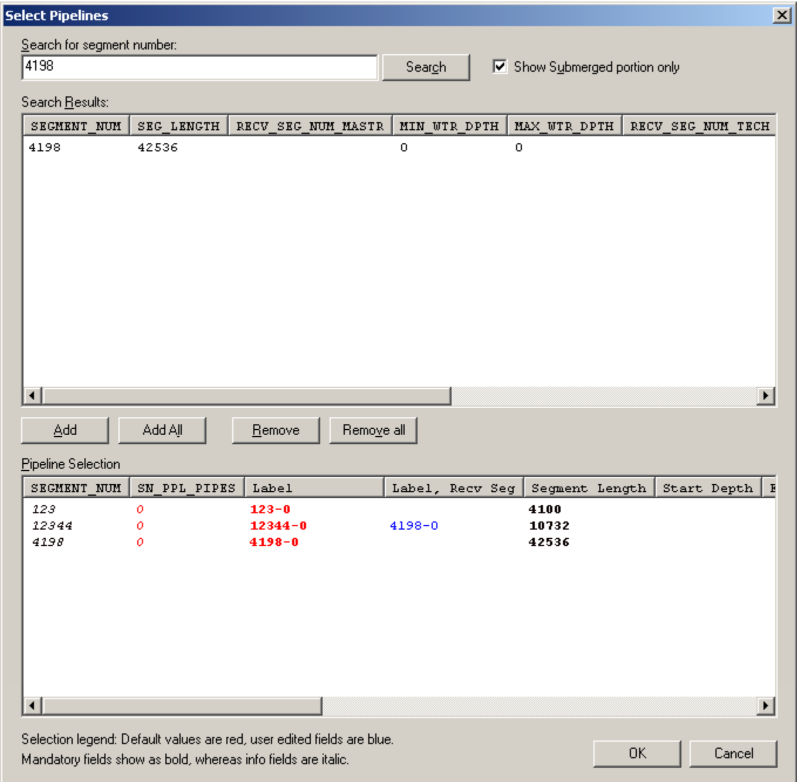


1.3 Using data from the MMS Pipeline Information Database

The POSVCM allows the user to draw data directly from the MMS Pipeline Information Database. To access the database, go to the menu item Object>From Database.



This brings up the Select Pipelines dialogue window:



By entering the desired pipeline segment numbers in the top dialogue box and clicking Select (or the Enter key on the keyboard), segment numbers with associated data are collected in the upper half of the window (the “Search Results” window). Any or all of these may then be added to the active Scenario using the Add and Add All buttons between the top and bottom windows, or by doubleclicking the desired segments. This will add segments to the current selection, shown in the lower half of the window (the “Pipeline Selection” window). Clicking OK closes the window, and places the selected pipeline segments in the active Scenario.

Data retrieved from the database for each pipeline segment include

- ID number,
- Length,
- Diameter and wall thickness (to compute inside diameter),
- Receiving segment number (to identify potential joins).

Other data, such as pipe grade and minimum and maximum water depths, are also retrieved, but are not used in the present version of the model. They are however displayed, in order to aid the user in selecting segments and editing data. For instance, minimum and maximum depth may give a hint to the start and end depth of a segment.

As described in the next chapter, a number of properties must be supplied for each pipeline segment. As far as possible, these are taken from the information in the database. Some data are however not available from the database, in which case the same default values as used elsewhere in the model are supplied.

Pipeline diameters are stored several places in the database. POSVCM uses the following strategy to assign an interior diameter to a selected pipeline segment. If the segment has an entry in the PPL_PIPES table, interior diameter is calculated as (LINE_OUT_DIAM – 2*LINE_WL_THCK). If the PPL_PIPES entry is not present, the PPL_SIZE_CODE field in PPL_MASTERS is tried. If this field contains a single code (e.g. 04, but not 04-06), the corresponding value is used[1]. Note that the difference between inner and outer diameter is now neglected. If the PPL_SIZE_CODE field contains several codes or is empty, the default value is used.

Font and color coding is used in the selection window to indicate field status. Some fields are mandatory, meaning that they must be supplied for the model to be able to run correctly. These are shown in bold. Optional fields are in standard font, whereas info fields containing data that is not used in the model show in italics. The text color indicates the data source. System default is used for data from the database, red is used for data supplied by the database module (e.g. default values), and user edited data is written in blue.

The user can edit field values by double-clicking the corresponding field. It is advised that the user consider editing data fields where default values are used for parameters central to the model, such as start and end depth.

Each selected pipeline segment is given a unique label. Labels are generated as [SEGMENT_NUM]-[SN_PPL_PIPES], but can be changed by the user after selection.

Pipeline segments can be connected by entering labels in the “Label, Recv Seg” field. This will create a joint between the two segments in the scenario. If either end depth of sending segment or start depth of receiving segment is specified, this will be used as the depth of their common joint. If both depths are given, depth of sender is used.

In some cases the database contains the segment number of the receiving segment. The user can then right-click the segment in the “Search Results” window and select “Search for receiving segment” from the drop-down menu to find the receiving segment. Note that the two segments are not automatically connected, this must be done by doubleclicking the “Label, Recv Seg” field of the sending segment and entering the receiving segment’s label.

All units are as in the main program when the user has selected to display “English (US)” units.

[1] The conversion from codes to diameter values is done according to the table in http://www.gomr.mms.gov/homepg/pubinfo/freeasci/pipeline/zipped/fixed/PipelineMastersFixeddom.html.

2 Object properties

After placing a selected object one has to supply required parameters. Right-click the object and choose Properties, or double-click and the Properties box appears. Fill in specifications for each object.

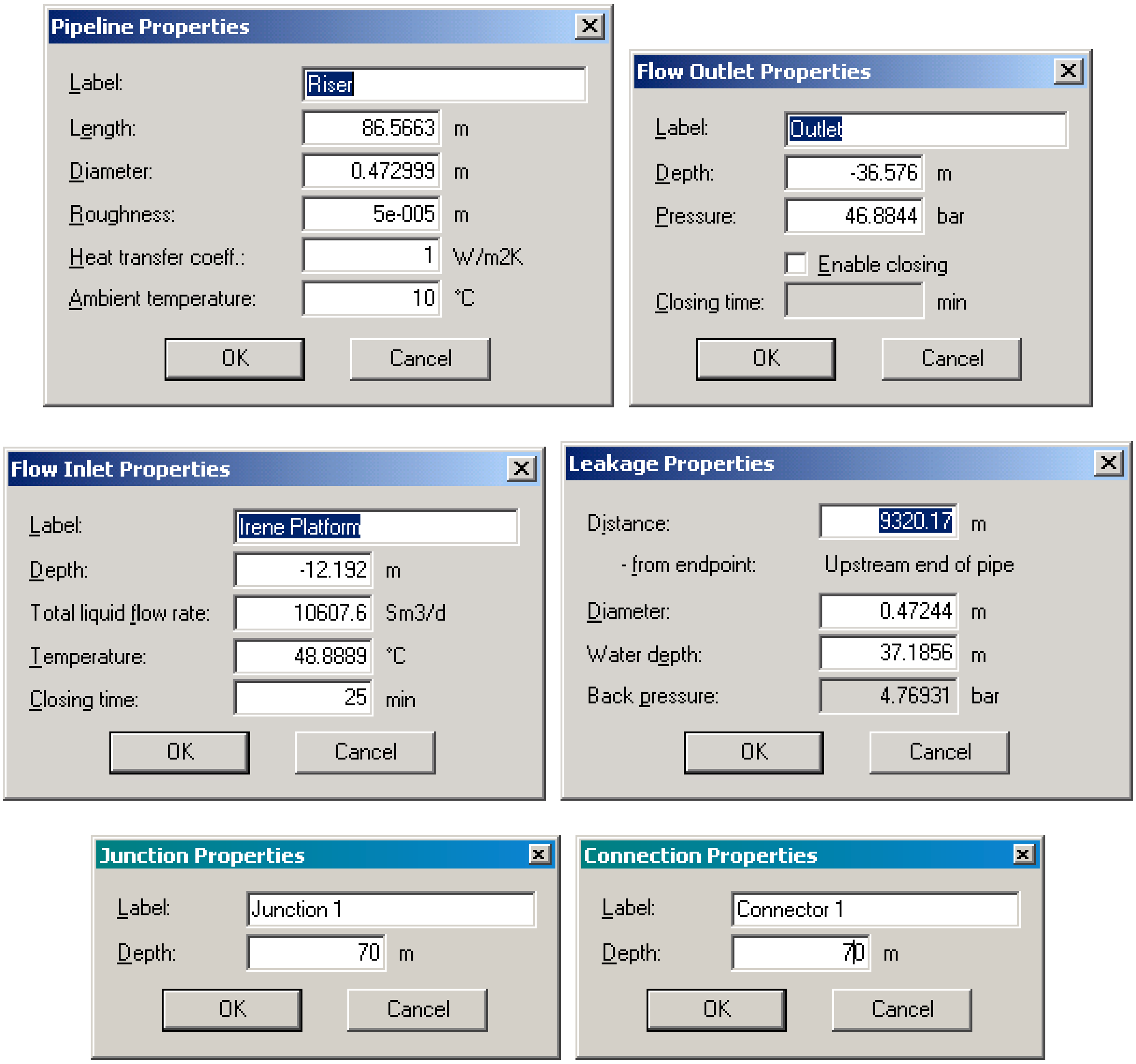


Figure 2.1 Object properties input dialogs. Labeling objects is not required, but is recommended as an assist in locating problems with the scenario setup.

3 Discharge calculation

3.1 Calculate discharge

After creating your analysis scenario, select Scenario menu\Verify Layout (or the Network Check button on the toolbar). This checks a number of potential problems in the network layout, such as:

- Missing or invalid object parameters,
- Outlet point connected to more than one in-coming branch,
- Pipeline segment shorter than depth difference between endpoints,
- Maximum number of objects exceeded (100 pipeline segments, 5 junction, 10 segments per junction), and
- More than one leakage point found.

In general, these messages are self explanatory, and lead the user quickly to the problem area.

If the "valid network" message appears one can continue with the analysis. Otherwise the message-box identifies the problem.

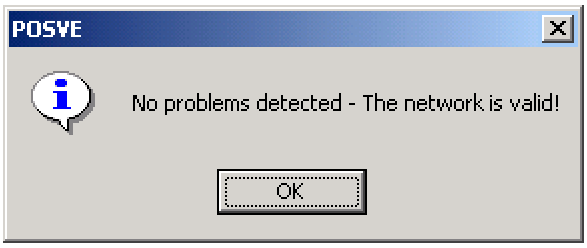


Figure 3.1 Corresponding message-box gives you the status of your analysis-scenario.

Shortcut: Select Calculate Discharge from the Scenario menu (or Worst case discharge button on the toolbar), automatically runs the Verify Layout test prior to estimating the discharge for the given scenario.

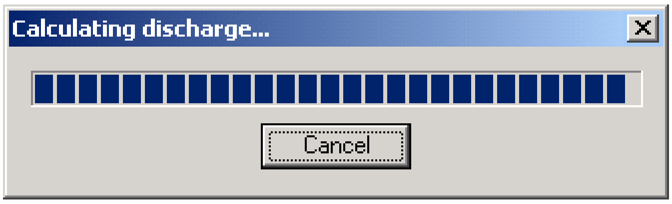
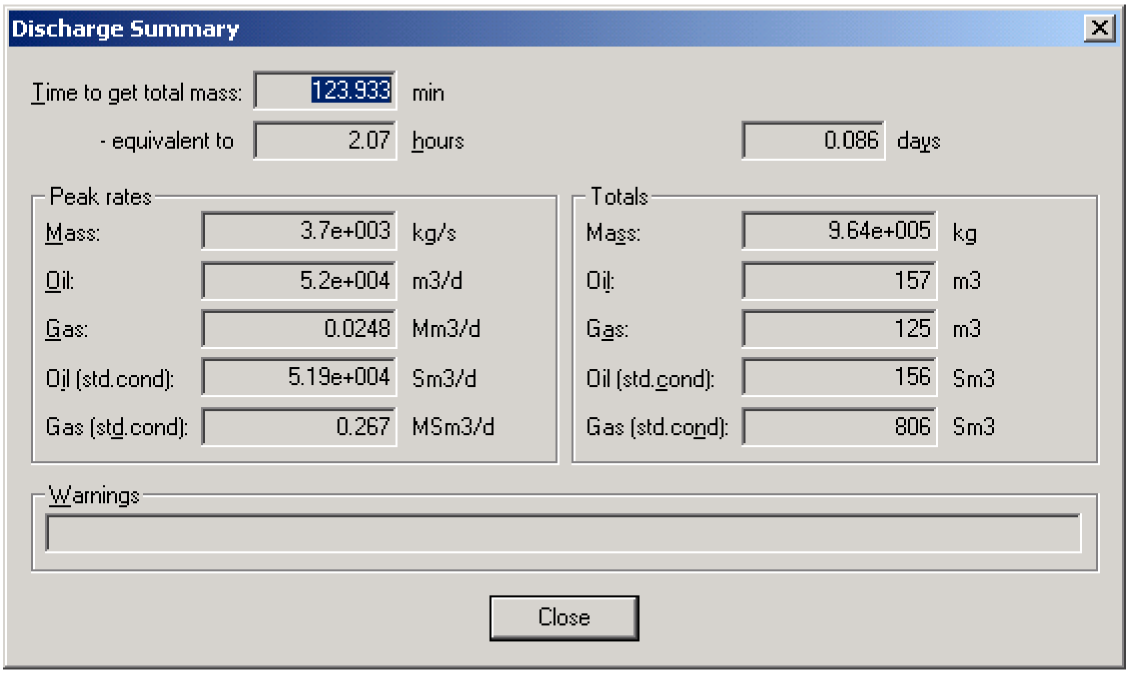
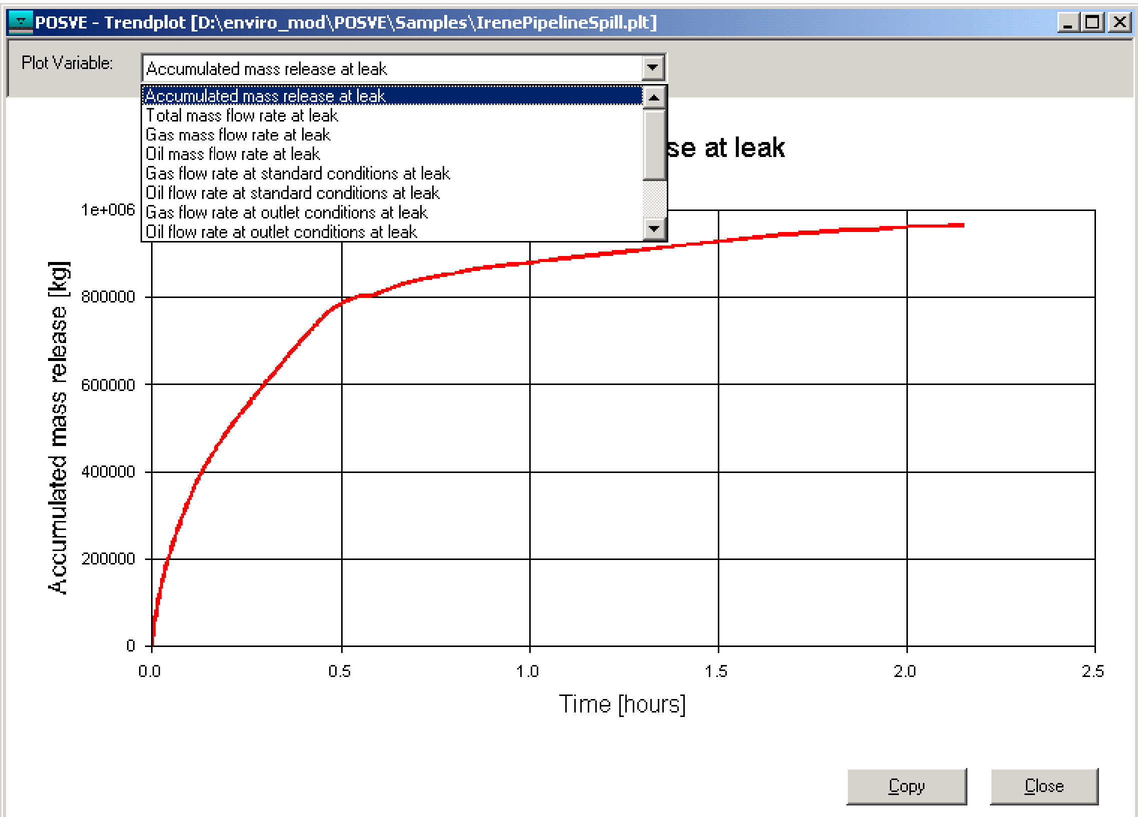


Figure 3.2 The progress bar allows you to follow the calculation process.

3.2 View discharge output

A Discharge Summary appears at completion of the discharge calculation, and is also accessible via the Result menu.





4 Near Field Module

4.1 Module setup

The Near Field Module consists of two models linked together in a single program, the oil and gas plume simulation model *DeepBlow* and the *Surfacing* model simulating the formation of surface slicks from oil droplets escaping from the plume. The two models are described in detail in the Technical Documentation of the MMS-POSVCM.

The Release module must be run before the Near Field module, since the latter uses results from the former to compute the thickness of oil at the sea surface. To set up the Near Field module, select the menu item Scenario, Near Field Setup (Figure 7.1).

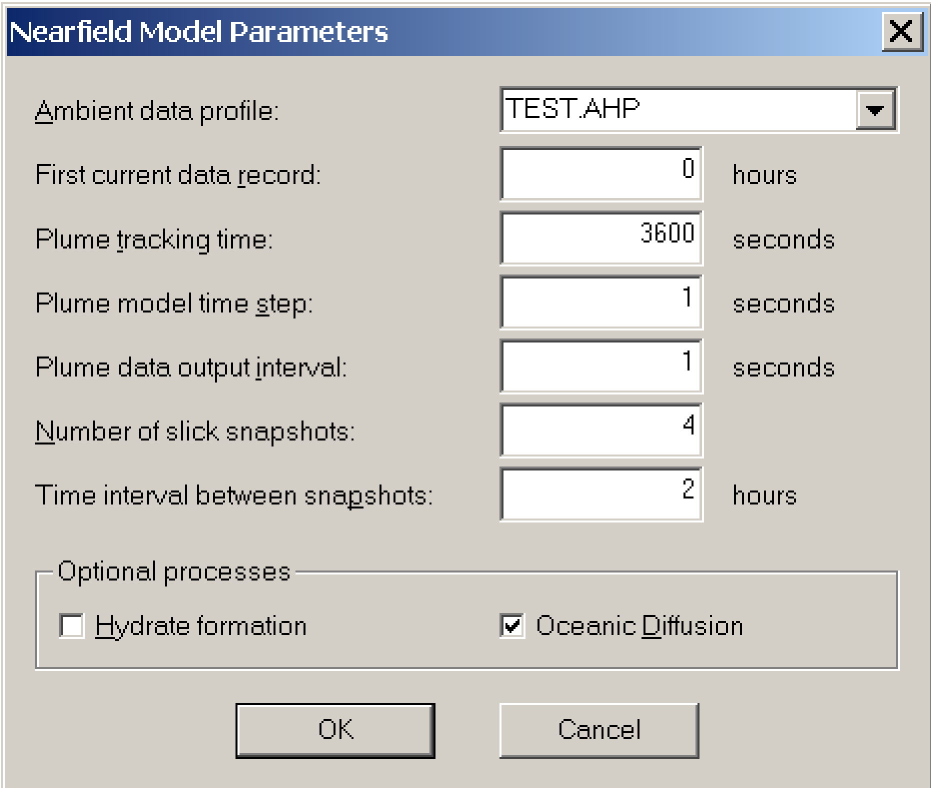


Figure 7.1 Near Field setup menu.

Description of entries in Near Field Setup:
<u>Ambient data profile</u>: The Near Field module requires as input vertical profiles for current and water temperature and salinity. These data are read in from three files located in the folder Ambient under the installation folder for the MMS-POSVCM. These files must be supplied be the user for the area of application. The formats for these text files are given in Figure 7.2.
<u>First current data record:</u> Determines the number of hours from the beginning of the current record to start the simulation.
<u>Plume tracking time:</u> Specifies the number of seconds to track the plume. Longer times are necessary for deeper waters and weaker source strengths. If the oil does not come to the surface, try a longer tracking time. Note that oil may never come to the surface if the release produces very small droplets.
<u>Plume model timestep</u>: Default of 1 second is usually OK.

Plume data output interval: Determines how often during the tracking time the plume formation data will be recorded.
Number of slick snapshots: Specifies number of snapshots of the surface slick to be recorded. The first snapshot occurs at the conclusion of the release.
Time interval between snapshots: Number of hours between subsequent snapshots.

ThreeMin.ACE - Notepad

File Edit Format Help

```
      10    300.00      0.05 ! East current
  8000.0     300.0     266.7     233.3     200.0     166.7     133.3     100.0      66.7      33.3       0.0
    0.00     14.79     13.71     15.91     16.40     14.50     16.15     16.66     15.77     16.24     16.33
    0.05     15.72     12.63     16.58     17.05     16.29     14.59     14.81     15.38     17.53     14.71
    0.10     14.83     12.84     17.37     17.77     15.04     14.58     15.84     15.38     18.09     15.43
    0.15     15.13     13.26     17.48     17.15     14.05     15.25     17.48     13.77     17.67     16.87
    0.20     13.98     14.37     16.93     17.79     12.64     13.93     16.70     12.62     16.28     15.48
    0.25     15.11     13.77     16.19     16.47     11.98     13.04     17.24     11.62     16.13     16.14
    0.30     14.30     14.65     16.46     14.89     12.41     14.09     16.29     10.38     17.61     16.74
    0.35     13.48     13.33     15.23     15.55     11.99     13.47     16.64     10.65     17.42     16.03
    0.40     14.87     14.46     16.70     13.94     11.02     14.25     17.12     10.42     17.24     16.20
    0.45     15.78     14.22     17.88     14.54     10.69     15.85     16.44     11.94     18.58     15.48
    0.50     16.66     15.16     16.02     13.11     10.53     14.10     17.47     13.28     19.49     14.33
    0.55     17.94     16.04     16.87     14.86     10.49     15.08     18.70     12.95     19.49     14.70
    0.60     17.90     16.60     16.42     13.68     11.98     16.09     17.89     11.05     17.83     13.55
    0.65     16.53     17.79     17.85     14.55     11.80     16.83     18.94     12.49     18.80     13.45
    0.70     15.28     17.28     16.72     14.34     10.13     16.20     17.06     14.02     18.57     13.03
```

(a)

ThreeMin.ACN - Notepad

File Edit Format Help

```
      10    300.00      0.05 ! North current
  8000.0     300.0     266.7     233.3     200.0     166.7     133.3     100.0      66.7      33.3       0.0
    0.00      8.72     10.16      8.59     10.47     10.85      8.49      8.37      8.46     11.20      8.85
    0.05     10.79      9.90      9.41      9.25     11.65      8.12      9.68      9.93     11.09      8.22
    0.10      9.97     11.44     10.96      9.20     12.35      8.28      8.79     11.67     12.63      7.17
    0.15     11.27      9.98     12.43      9.30     14.16     10.21      9.74     12.74     12.31      7.78
    0.20     11.84     11.35     12.92      9.79     14.56     10.45     10.39     11.67     12.05      8.37
    0.25     12.05     11.43     11.97     11.19     14.50     10.45      9.83     10.65     13.44      9.18
    0.30     12.31     11.65     11.89     11.96     14.61     11.91      9.20     10.56     13.78     10.14
    0.35     11.07     10.71     12.81     11.11     14.58     13.83      9.16     10.07     14.47      9.65
    0.40     10.74      9.83     14.62     12.53     14.57     14.13      9.23     11.22     15.79     10.31
    0.45     11.30     10.89     14.08     11.64     14.86     16.01      8.87     10.44     16.29      8.99
    0.50     10.56     12.27     14.01     11.51     15.94     17.65     10.79     10.41     16.26      8.97
    0.55     10.16     10.85     15.37     10.40     14.57     16.98     10.72      9.68     15.63      9.67
    0.60      9.74     11.98     16.35     11.72     15.19     16.89     10.67     11.75     16.01      9.77
    0.65      8.48     12.12     17.75     13.76     15.00     16.33     11.62     12.92     14.63      9.98
    0.70      9.87     13.31     19.24     13.37     15.07     17.67     13.44     13.23     16.47      9.64
```

(b)

ThreeMin.AHP - Notepad

File Edit Format Help

```
   5.00  8.50 35.00 Blokk 7122/7 August (PL 229)
  12.50  8.40 35.00
  25.00  8.30 35.00
  37.50  7.70 35.00
  50.00  7.50 35.00
 100.00  6.20 35.00
 150.00  5.70 35.00
 200.00  5.50 35.00
 450.00  5.30 35.00
```

(c)

Figure 7.2 Input file formats for vertical current and hydrographic data for the Near Field module. Figures (a) and (b) show the North and East velocity component files. The first row gives the number of depth intervals (10 in this example), the total depth (300 m here), and the time step between subsequent records (0.05 hr, or 3 min here). The second row is the start time with time in hours from the reference date January 1, 1900, in the first column, and the depths of the measurements following. Subsequent records are the time and associated current magnitudes (cm/sec).

The Near Field setup allows the user to specify a start time in the velocity files, a duration for the time series computation of the near field plume, the computational time step, the output interval, the number of snapshots to be recorded, and the time interval between snapshots.

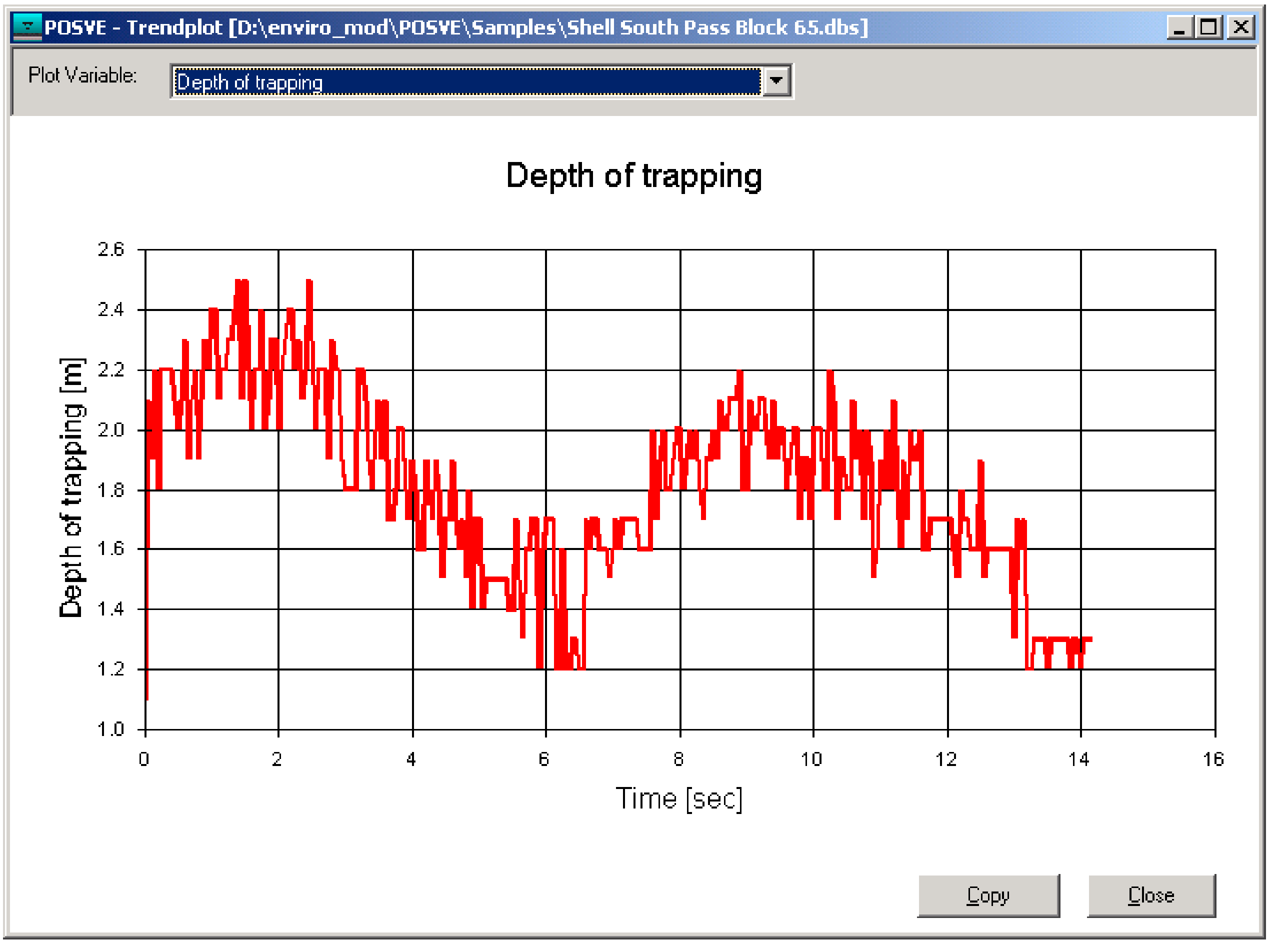
The distribution of oil thickness at the sea surface, as computed by the Near Field module, is found in the file *scenario*.COT. This file can be imported into a spreadsheet program to display a gridded map of the surface slick thickness.

4.2 View Nearfield output

4.2.1 Time series plots

Time series results from the Nearfield module are available under the menu item Result/Nearfield plot. Quantities available are

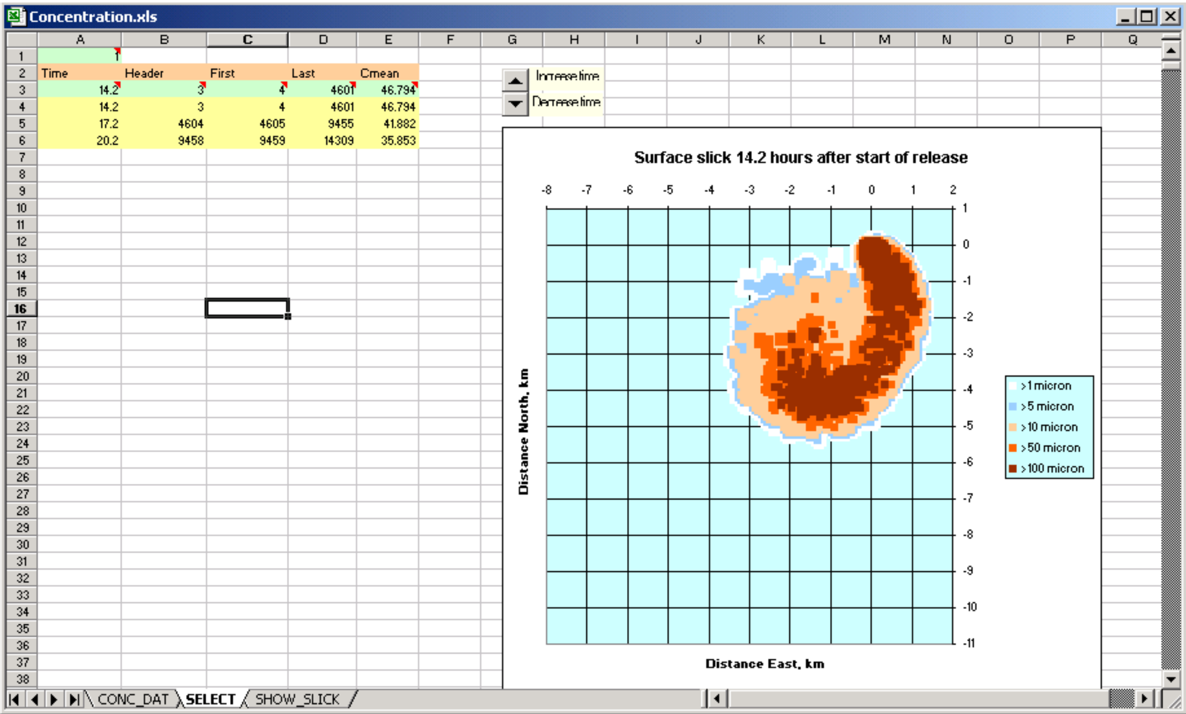
- Depth of trapping (m)
- Distance East or North (m)
- Plume radius (m)
- Horizontale and vertical velocities (cm/s)
- Source strength (m2/s)
- 95th percentile droplet size (mm)
- Rise time (sec)
- Oil concentration (ppm)
- Remaining fraction of gas (%)
- Dissolved fraction of oil (%)
- Fraction of gas in hydrate (%)



4.2.2 Surface distribution of oil

A spreadsheet file, Concentration.xls, is supplied to assist in plotting 2-dimensional distributions of oil on the sea surface. Both the discharge and nearfield modules must have been run prior to viewing surface thickness distributions.

Upon opening, Concentration.xls prompts the user for an input file (scenario.COT). After selection, the embedded macros will load the data from the file. This may take a little time, depending on how often data was specified to be saved in the scenario Nearfield setup. To load a new file, use the toolbar button "load file….."



The surface plot for the first timestep stored will appear on the worksheet "Select". To advance the surface plot in time, use the up arrow on the spreadsheet. Use the down-arrow to plot an earlier time. The available times are shown in the time-box in the upper left corner of the spreedsheet.

To adjust the thickness key, change value of the parameter Cmin at the top of the worksheet "Show Slick". Then click the "Set value" button to the right to register the new value in the data set.

4.3 Examples of content of the different output files are given in the end of the section

scenario.**DBS**
Summary of results from plume simulation.

Parameter	Unit	Explanation
HOUR	hours	Start time of individual plume simulations with reference to times in the current data record
H	m	Depth corresponding to maximum plume rise (Depth of Trapping, DOT)
X	m	East displacement of plume at DOT
Y	m	North displacement of plume at DOT
R	m	Plume radius at DOT
U	cm/s	Horizontal component of plume velocity at DOT
W	cm/s	Vertical component of plume velocity at DOT
Str	m^2/s	Source strength, measure of surface spreading rate for surfacing plumes
D95	mm	95% maximum droplet size formed at exit
Time	seconds	Rise time to DOT
ppm	1.e-6	Oil concentration in plume at DOT
%G	%	Mass fraction of gas reaming as gas bubbles at DOT
%D	%	Mass fraction of gas dissolved in plume at DOT
%H	%	Mass fraction of gas in hydrate at DOT

scenario.**DBP**
Data on individual plume trajectories.
Repeated for each plume, separated by one line.

Parameter	Unit	Explanation
First column	hours	First row in sequence: Start time in hours of individual plume simulations with reference to times in the current data record.
	seconds	Subsequent rows: Rise time in seconds from start of plume trajectory. Note: Time intervals determined in user interface.
X	m	East displacement of plume centerline
Y	m	North displacement of plume centerline
H	m	Depth of plume centerline
R	m	Plume radius
U	cm/s	Horizontal component of plume velocity
W	cm/s	Vertical component of plume velocity
T	^{o}C	Temperature in plume
S	1.e-3	Salinity in plume
ppm	1.e-6	Oil concentration in plume
Gas	%	Mass fraction of gas remaining as gas bubbles
Diss	%	Mass fraction of gas dissolved in plume
Hydrate	%	Mass fraction of gas in hydrate

***scenario*.COS**
Summary data for surface slicks

Parameter	Unit	Explanation
Time	hours	Time from start of release
Qrel	m^3	Released oil volume
Qsurf	m^3	Surfaced oil volume
%	%	Volume fraction of oil surfaced
Microns	1.e-6 m	Average thickness of surface slick

***scenario*.COT**
Distribution of film thickness in surface slick at different times after release (snapshots)
First snapshot at end time of release. Sequence repeated for each snapshot, separated by blank line.

Parameter	Unit	Explanation
First row in sequence	hours	Text including time of the snapshot in hours from start of release
Second row in sequence		$1 – 4^{th}$ column: Column headers in sequence 5^{th} column: Time from start, hours 6^{th} column: Number of rows in sequence 7^{th} column: Average surface film thickness, microns
NCL	m	Cell number
km_East	m	Distance of cell east of discharge point
km_North	m	Distance of cell north of discharge point
microns	1.e-6 m	Oil film thickness in cell

Example of file *scenario*.DBS: Summary of results from plume simulation

HOUR	H	X	Y	R	U	W	Str	D95	Time	ppm	%G	%D	%H
120.0	10.7	46.7	-27.6	34.7	11.1	35.0	268.7	3.6	583.0	38.9	55.0	22.1	0.0
120.5	6.5	45.4	-22.6	29.6	12.7	60.1	387.7	3.1	475.0	18.5	72.2	20.6	0.0
121.0	8.6	56.7	-19.7	31.5	15.6	55.1	381.9	3.4	475.0	10.7	66.7	20.3	0.0
121.5	17.0	74.4	-14.7	38.8	18.2	37.8	333.1	3.7	502.0	7.6	55.5	20.1	0.0
122.0	35.3	98.3	-4.6	48.2	21.8	20.4	256.5	4.1	541.0	5.9	39.0	19.7	0.0
122.5	45.7	110.9	10.8	51.7	24.0	13.0	210.3	4.5	571.0	4.8	31.6	19.9	0.0
123.0	53.9	133.9	32.1	54.2	25.4	2.6	95.7	4.9	650.0	4.0	19.2	20.0	0.0
123.5	93.7	682.2	375.2	95.5	27.4	5.4	253.9	5.4	3023.0	1.0	0.0	24.2	0.0
124.0	74.3	140.2	71.9	50.6	27.7	0.0	0.0	6.0	694.0	3.2	11.6	19.0	0.0
124.5	81.4	137.3	92.8	48.8	28.7	0.0	0.0	6.6	712.0	3.0	9.1	18.4	0.0
125.0	91.9	132.4	117.6	47.0	28.4	0.0	0.0	7.3	758.0	2.9	5.5	16.7	0.0
125.5	100.1	125.2	135.6	46.1	27.7	0.0	0.0	8.0	798.0	2.7	3.8	16.1	0.0
126.0	106.3	105.0	149.5	44.4	27.9	0.0	0.0	8.9	803.0	2.5	3.1	15.3	0.0
126.5	113.7	83.9	156.6	42.8	26.4	0.0	0.0	9.9	815.0	2.5	2.2	13.8	0.0
127.0	123.8	60.1	160.3	41.9	24.1	0.0	0.0	11.3	845.0	2.5	1.4	12.0	0.0
127.5	216.1	9.9	366.3	33.7	18.2	0.0	0.0	11.7	1913.0	1.5	0.0	3.7	0.0
128.0	267.0	-235.0	613.2	11.1	20.8	0.0	0.0	11.7	3223.0	2.2	0.0	0.2	0.0
128.5	276.0	-296.1	482.4	7.7	18.4	0.0	0.0	11.7	3121.0	1.8	0.0	0.0	0.0

Example of *scenario*.DBP: Data on individual plume trajectories
Note: Only first two sequences shown.

120	X	Y	H	R	U	W	T	S	ppm	Gas	Diss	Hydr
1	0.1	-0.1	296.8	0.6	11.2	99.7	5.5	35.0	49450.8	100.0	0.0	0.0
60	2.9	-4.9	251.3	6.1	7.0	63.4	5.4	35.0	732.2	96.5	3.5	0.0
120	5.1	-8.1	216.2	10.1	6.8	55.1	5.5	35.0	301.8	93.4	6.6	0.0
180	7.8	-12.0	184.3	13.5	9.0	51.9	5.5	35.0	179.6	90.4	9.5	0.0
240	11.5	-16.8	153.9	16.7	10.9	49.4	5.5	35.0	122.1	85.4	12.2	0.0
300	16.5	-21.0	124.7	19.7	10.6	47.8	5.6	35.0	91.1	79.3	14.6	0.0
360	22.1	-23.9	96.6	22.5	10.6	46.0	5.7	35.0	71.8	73.8	16.7	0.0
420	28.3	-25.8	70.1	26.6	11.1	41.6	5.9	35.0	56.8	69.3	18.6	0.0
480	35.1	-26.8	46.8	31.0	11.5	36.6	6.1	35.0	46.7	64.4	20.2	0.0
540	41.9	-27.3	25.5	33.6	11.3	34.6	6.3	35.0	41.9	58.6	21.4	0.0

120.5	X	Y	H	R	U	W	T	S	ppm	Gas	Diss	Hydr
1	0.1	-0.1	296.5	0.7	13.0	109.1	5.5	35.0	22301.6	100.0	0.0	0.0
60	4.3	-5.1	245.9	6.7	8.8	70.8	5.4	35.0	308.9	96.4	3.6	0.0
120	8.0	-8.5	206.5	11.2	8.8	62.0	5.5	35.0	126.0	93.2	6.8	0.0
180	12.1	-12.7	170.4	14.9	10.8	59.0	5.5	35.0	74.2	90.2	9.8	0.0
240	17.4	-17.1	135.5	18.4	11.7	57.3	5.6	35.0	50.4	86.5	12.5	0.0
300	23.8	-19.9	101.6	21.7	11.7	55.9	5.7	35.0	36.8	82.6	15.1	0.0
360	30.8	-21.6	68.5	25.2	12.4	54.0	5.9	35.0	28.3	78.8	17.3	0.0
420	38.4	-22.4	36.7	28.4	12.8	53.0	6.2	35.0	22.6	74.8	19.2	0.0

Example of *scenario*.COS: Summary data from surface slick calculations

RELEASE START AT CURRENT RECORD TIME, hrs: 120.0
RELEASE DURATION, hrs: 9.0

Time	Qrel	Qsurf	%	Microns
9	429.8	429.1	99.9	39.1
10	429.8	429.7	100.0	30.3
11	429.8	429.8	100.0	27.3
12	429.8	429.8	100.0	25.1
13	429.8	429.8	100.0	22.9
14	429.8	429.8	100.0	20.0

Example of *scenario*.COT : Distribution of film thickness in surface slicks.
Note: Only parts of first sequence shown.

CONCENTRATIONS_AT_TIME,_hours: 9.0

NCL	km_East	km_North	microns			
				9	482	39.1
1	-0.188	0.747	2.680			
2	-0.037	0.747	36.447			
3	0.114	0.747	5.310			
4	-0.188	0.898	2.168			
5	-0.037	0.898	38.307			
6	0.114	0.898	4.877			
7	0.265	0.898	0.105			
8	-0.188	1.049	0.450			
9	-0.037	1.049	0.829			
10	0.114	1.049	0.886			
11	0.265	1.049	0.574			
12	0.416	1.049	0.120			

5 Table of Conversions

To convert from	To	Multiply by
m	in	39.37
m	ft	3.281
ft	in	12
Bar	Psi	14.504
Bar	Pascals	100,000
°F	°C	$(T_F - 32)\ 0.5556$
°C	°F	$1.8\ T_C + 32$
$Sm^3/\ Sm^3$	Scf/bbl	5.615
lb/ft^3	Specific gravity [-]	0.01602
kg/m^3	lb/ft^3	0.06243
kg/m^3	Specific gravity [-]	0.001
Specific gravity [-]	API gravity [-]	(141.5/Specific gravity) – 131.5
kg/m^3	Gas gravity [-]	1/1.234

6 Example Test Cases

Open an empty scenario window and fill in objects with properties as described in the properties table below, and connect them as shown in Figure 6.1 and Figure 6.3. Then click the Worst case discharge button on the toolbar, and compare model results with those shown in Figures 6.2 and 6.4.

6.1 Example scenario 1: IrenePipelineSpill.wcd

Fluid properties:

Oil density	kg/Sm^3	800
Gas density: default to 1 kg/Sm^3		1
Gas-Oil Ratio	Sm^3/Sm^3	5.3
Water Cut	%	84

Flow inlet properties:

Depth	m	-12
Total liquid flow rate	$Sm^{3/d}$	10607
Fluid temperature	deg.C	49
Closing time	min	25

Pipeline 1: "Riser"

Length	m	86.5
Diameter	m	0.473
Roughness coefficient: default to 5.0 x 10^{-5}		5e-005
Heat transfer coefficient: default to 1 J/s		1
Ambient temperature	deg.C	10

Pipeline 2: "Torch 20-inch line"

Length	m	19202
Inside diameter	m	0.473
Roughness coefficient: default to 5.0 x 10^{-5}		5e-005
Heat transfer coefficient: default to 1 J/s		1
Ambient temperature	deg.C	10

Pipe connector or junction:

Depth	m	74

Outlet:

Depth	m	36.5
Fluid pressure	bar	46.8
Closing time		

Leak properties:

Distance from upstream endpoint	m	9320
Nominal diameter	m	0.473
Water depth.	m	38

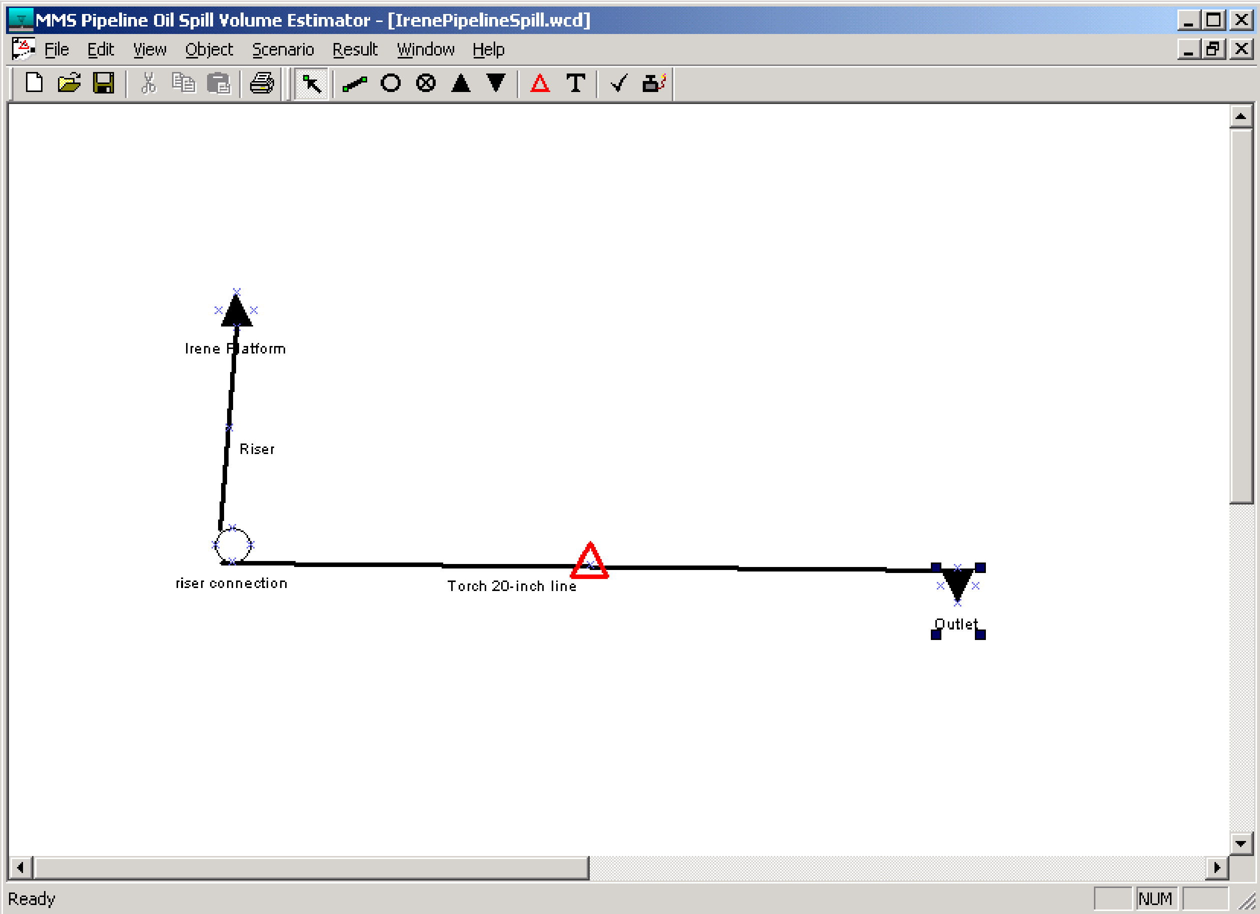


Figure 6.1 Graphical description of the Irene Pipeline Spill.

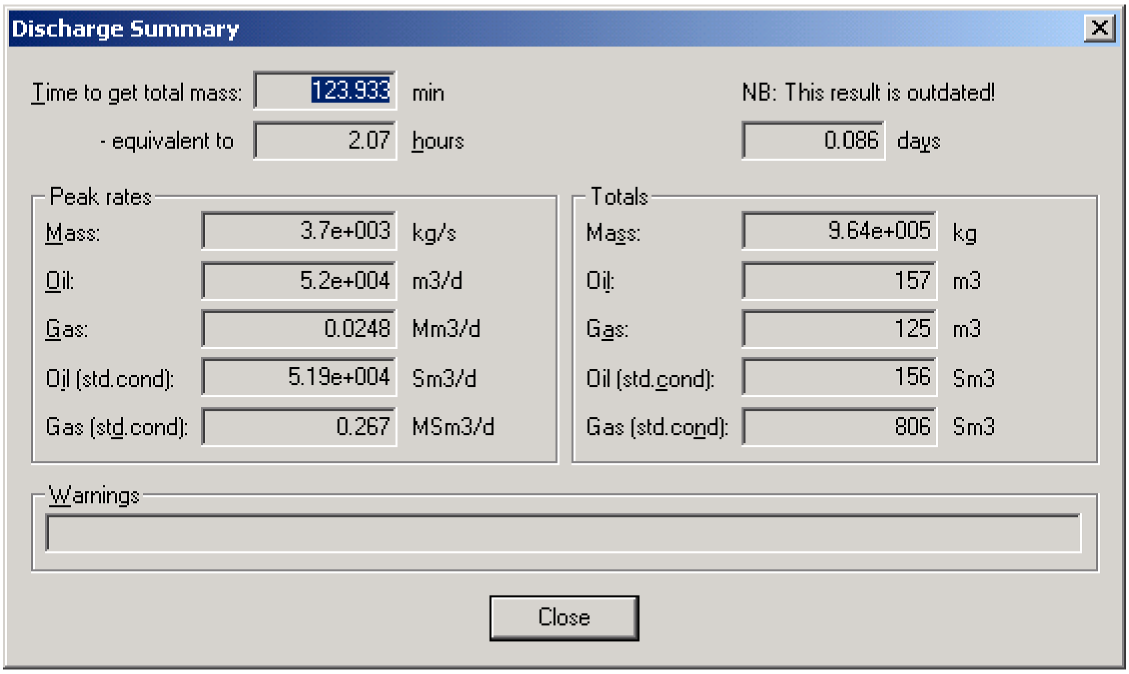


Figure 6.2 Result window for the Irene Pipeline Spill.

6.2 Example scenario 2: ChevronSouthPass_with_risers

Fluid properties:

Oil density	kg/Sm^3	800
Gas density: default to 1 kg/Sm^3		1
Gas-Oil Ratio	Sm^3/Sm^3	4.5
Percent water in fluid	%	80

Flow inlet 1: Cusa Platforms MC 49A,B,C

Depth	m	-25
Total liquid flow rate	Sm$^{3/d}$	1000
Fluid temperature	deg.C	60
Closing time	min	60

Pipeline 1: "Pipe 10" Line to Cusa"

Length	m	12000
Inside diameter	m	0.25
Roughness coefficient: default to 5.0 x 10^{-5}		5e-005
Heat transfer coefficient: default to 1 J/s		1
Ambient temperature	deg.C	20

Flow inlet : Taylor Platform MC20

Depth	m	-25
Total liquid flow rate	Sm$^{3/d}$	100
Fluid temperature	deg.C	60
Closing time	min	60

Pipeline : "8" line to Taylor"

Length	m	16226
Inside diameter	m	0.2
Roughness coefficient: default to 5.0 x 10^{-5}		5e-005
Heat transfer coefficient: default to 1 J/s		1
Ambient temperature	deg.C	5

Pipe junction:

Depth	m	120

Pipeline: "Pipe 10" Line upstream from BP"

Length	m	1000
Inside diameter	m	0.2
Roughness coefficient: default to 5.0 x 10^{-5}		5e-005
Heat transfer coefficient: default to 1 J/s		1
Ambient temperature	deg.C	20

Flow inlet : BP Platform MC109

Depth	m	-25
Total liquid flow rate	Sm$^{3/d}$	1637
Fluid temperature	deg.C	60
Closing time	min	60

Pipeline: "10" line to BP"

Length	m	11812
Inside diameter	m	0.25
Roughness coefficient: default to 5.0 x 10^{-5}		5e-005
Heat transfer coefficient: default to 1 J/s		1

Ambient temperature	deg.C	20

Pipe junction:

Depth	m	120

Pipeline : " Pipe 10" Line Upstream from BP "

Length	m	20000
Inside diameter	m	0.25
Roughness coefficient: default to 5.0 x 10^{-5}		5e-005
Heat transfer coefficient: default to 1 J/s		1
Ambient temperature	deg.C	20

Flow inlet : OXY Platform SP 45

Depth	m	25
Total liquid flow rate	$Sm^{3/d}$	30
Fluid temperature	deg.C	60
Closing time	min	60

Pipeline: " 4" line to OXY "

Length	m	1438
Inside diameter	m	0.1
Roughness coefficient: default to 5.0 x 10^{-5}		5e-005
Heat transfer coefficient: default to 1 J/s		1
Ambient temperature	deg.C	20

Pipe junction:

Depth	m	40

Pipeline: " Pipe 10" Line to Outlet"

Length	m	11100
Inside diameter	m	0.25
Roughness coefficient: default to 5.0 x 10^{-5}		5e-005
Heat transfer coefficient: default to 1 J/s		1
Ambient temperature	deg.C	20

Outlet: " on shore"

Depth	m	15
Fluid pressure	bar	2.5308
Closing time	min	

Leak properties:

Distance from upstream endpoint	m	5000
Nominal diameter	m	0.25
Water depth.	m	40

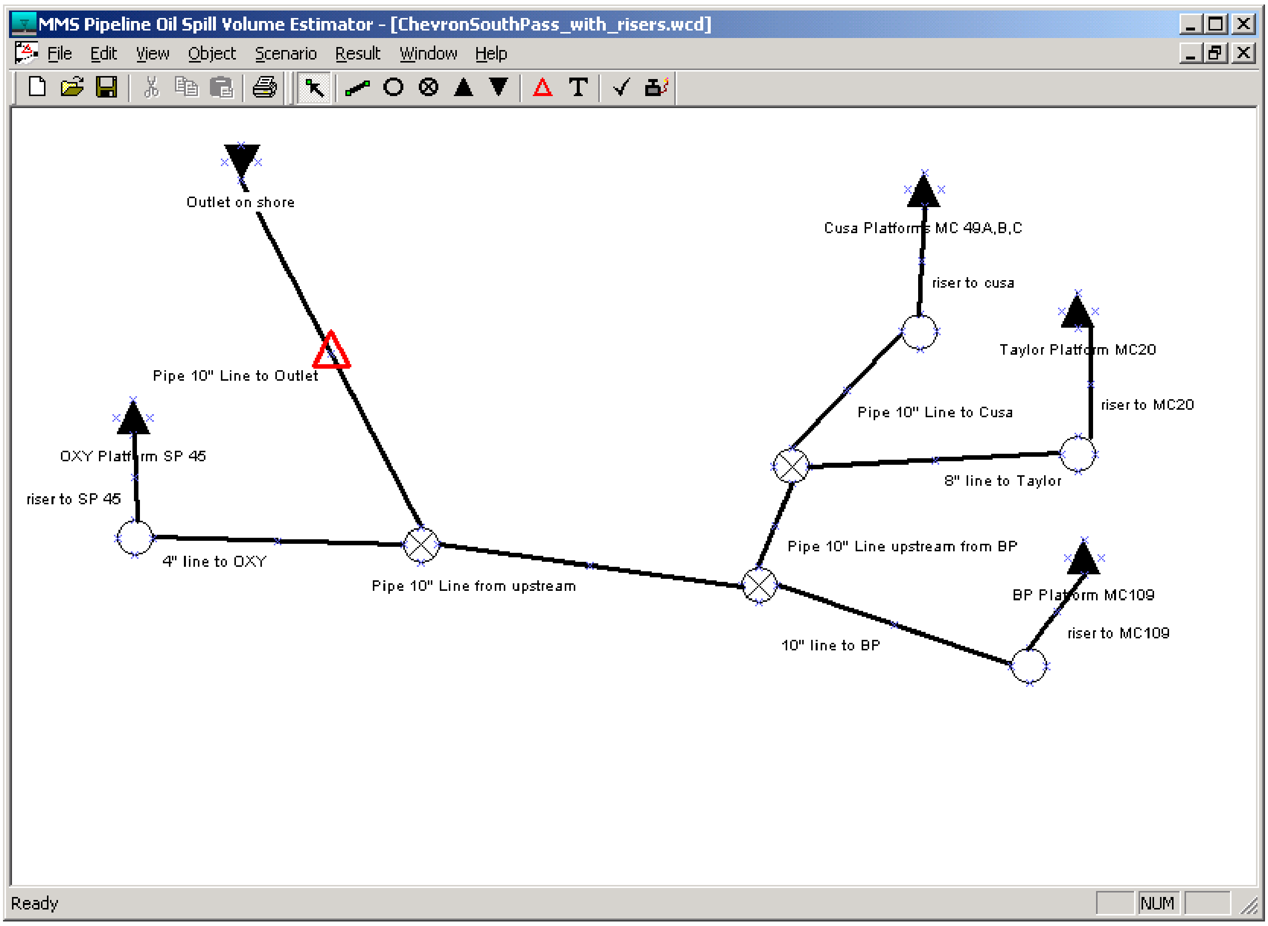


Figure 6.3 Graphical schematic of the Chevron South Pass Spill.

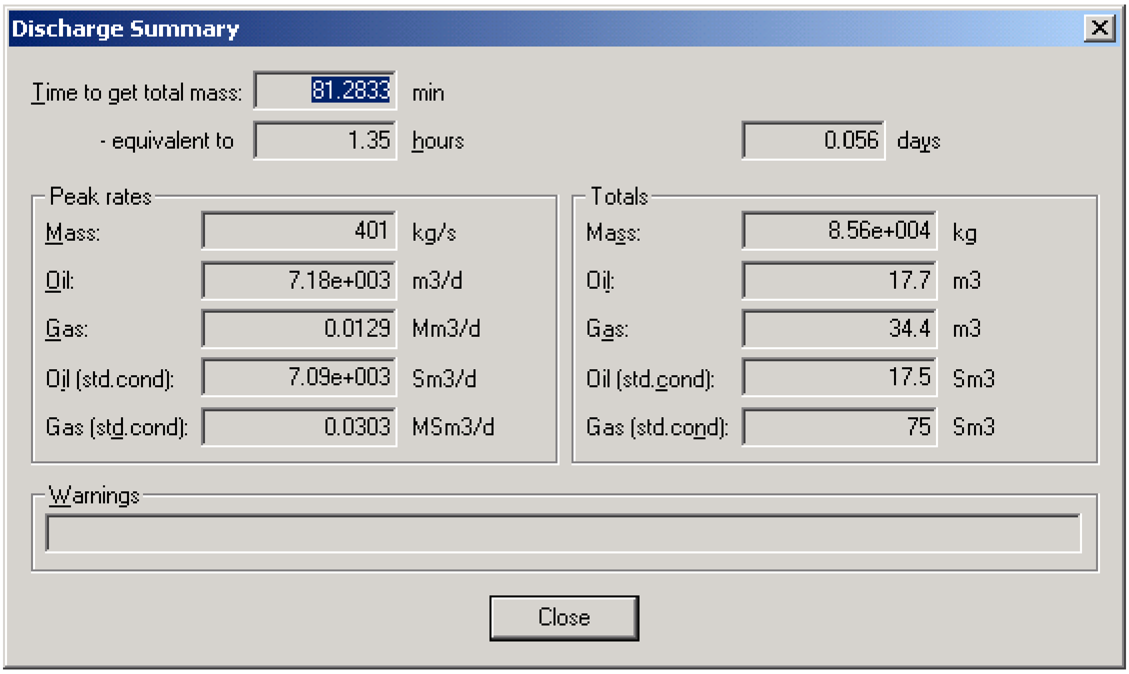


Figure 6.4 Result window for the Chevron South Pass Spill